Heart 1996;**76**:18–23

Out-of-hospital cardiac arrests in Helsinki: Utstein style reporting

M Kuisma, T Määttä

Abstract

***Objective*—To determine the epidemiology of out-of-hospital cardiac arrests and survival after resuscitation and to apply the Utstein style of reporting to data collection.**

***Design*—Prospective cohort study.**

***Setting*—A middle-sized urban city (population 516 000) served by a single emergency medical services system.**

***Patients*—Consecutive prehospital cardiac arrests occurring between 1 January and 31 December 1994.**

***Intervention*—Advanced cardiac life support according to the recommendations of American Heart Association.**

***Main outcome measures*—Survival from cardiac arrest to hospital discharge, and factors associated with survival.**

***Results*—Four hundred and twelve patients were considered for resuscitation. The overall incidence of out-of-hospital cardiac arrest was 79·8/100 000 inhabitants/year. Fifty seven patients (16·6%) survived to discharge when resuscitation was attempted. 32·5% survived when cardiac arrest was bystander witnessed and was of cardiac origin with ventricular fibrillation as the initial rhythm. When asystole or pulseless electrical activity was the first rhythm recorded, discharge rates were 6·2 and 2·7% respectively. The cause of cardiac arrest was cardiac in 66·5%, and ventricular fibrillation was the initial rhythm in 65·0% of bystander witnessed cardiac arrests of cardiac origin. 22·1% of patients received bystander initiated cardiopulmonary resuscitation. The mean time intervals from the receipt of the call to the arrival of a first response advanced life support unit and mobile intensive care unit at the patient's side and to the return of spontaneous circulation were 7·0 and 10·3 and 12·6 and 16·7 min respectively. In the logistic regression model bystander witnessed arrest, age, ventricular fibrillation as initial rhythm, and the call-to-arrival interval of the first response unit were independent factors relating to survival. Utstein style reporting with modification of time zero was found to be an appropriate form of data collection in this emergency medical services system.**

***Conclusions*—After implementation of major changes in the emergency medical services system during the 1980s survival from out-of-hospital cardiac arrest markedly increased. However, early access, which has turned out to be the weakest link in the chain of survival, should receive major attention in the near future. Utstein style reporting with a modified time zero was found to be appropriate, although laborious, protocol for data collection.**

(*Heart* 1996;**76**:18–23)

Keywords: cardiac arrest; out-of-hospital resuscitation; survival; Utstein style

Helsinki Emergency Medical Services System, Department of Health, Helsinki, Finland
M Kuisma
T Määttä

Correspondence to:
Dr M Kuisma, Helsinki Emergency Medical Services System, Department of Health, Agricolankatu 15 A, SF-00530, Helsinki, Finland.

Accepted for publication
13 February 1996

Utstein recommendations were introduced in the beginning of 1990s to standardise data reporting on out-of-hospital cardiac arrests.[1] There had been wide variation in survival rates depending on the case and survival definition selected.[2–4] However, even today there are no epidemiologically comprehensive prospective studies in which none of the important subgroups of the Utstein template (such as cardiac arrests of non-cardiac origin or cardiac arrests in which resuscitation is not attempted) are excluded. The aim of this study was to report the incidence of out-of-hospital cardiac arrests as well as survival after resuscitation in the middle-sized urban city of Helsinki and to apply the Utstein style of reporting to data collection.

Patients and methods

HELSINKI EMERGENCY MEDICAL SERVICES SYSTEM

Helsinki is the capital city of Finland with a population of 516 000 and a geographic area of 590 km^2. Of the population, 16·6% is younger than 16 and 14·0% older than 65 years.

Each year the Helsinki 112 Dispatching Centre dispatches 34 000 urgent medical missions in Helsinki. It is a combined centre for medical, fire, and rescue emergencies. In addition to Helsinki, it serves the province of Uusimaa which increases the population of the dispatching area up to 1 000 000. Dispatch is criteria based, computer aided, and the dispatchers are full time employees and have passed a medical dispatching course. Most dispatchers give telephone assisted instructions for cardiopulmonary resuscitation. The service routinely dispatches assistance during event interrogation. The first unit should be dispatched within one minute and the unit should be mobile within two minutes of the receipt of the call.

The emergency medical services system is three tiered and responsible for urgent calls. Both administratively and functionally it is founded on close cooperation between the rescue department and the health authority. Non-urgent calls are taken care of by two private enterprises. The city is divided into eight areas each of which has an own rescue station. The first tier consists of six ambulances and eight fire engines (used as first response units) staffed with emergency medical technicians who are can defibrillate, insert an intravenous line, and intubate adults. The first response unit turns the automated electrical defibrillator on when they arrive at the patient's side in order to register the exact time they reach the patient. The clocks of the defibrillators are synchronised with the time in the dispatching centre and checked daily. Three advanced life support units manned with emergency medical technicians with training in advanced life support make up the second tier, who can administer intravenous drugs. The third tier is the physician staffed mobile intensive care unit. Physicians are also responsible for medical direction, education, and development programmes in the emergency medical services system.

The calls are classified to four categories; D is non-urgent, C is urgent and the patient has to be reached in 20 minutes (neither blue lights nor siren), and B is urgent with medium or unknown risk (blue lights and siren) and attended by basic and/or advanced life support units. For A calls the nearest unit and mobile intensive care unit are dispatched simultaneously for high risk missions such as severe chest pain, severe trauma, and cardiac arrests. During simultaneous A calls one of the advanced life support units (medical supervisor) is dispatched and the mobile intensive care unit is informed.

Since the previous study in Helsinki in 1987,[5] there have been major changes in emergency medical services system; the introduction of automated electrical defibrillators in 1988, the change from two to three tiered emergency medical services system in 1989 (until then the mobile intensive care unit was the only advanced life support provider), employing full time dispatchers from 1990, the use of fire engines as first response units in medical emergencies since 1990, and telephone assisted cardiopulmonary resuscitation since 1992.

The resuscitation protocol has followed the guidelines of American Heart Association.[6] Emergency medical technicians begin resuscitation when there are no irreversible signs of death. Do-not-resuscitate decisions are made by the physician on duty. Excluding hypothermia cases, patients are completely stabilised where they are found and efforts stopped when there is no response to resuscitation attempts. Patients are transported to four receiving hospitals; two secondary and one tertiary care facilities for adult patients and one tertiary care facility for children.

DATA COLLECTION

The study plan was approved by the ethics committee of the City Health Department. All out-of-hospital cardiac arrest patients within the city limits with no irreversible signs of death, were included in the study. Data were prospectively collected according to a modified Utstein style.[1] The physician on duty in the mobile intensive care unit filled in a special study form during each event which was checked next weekday by the investigator. For simultaneous calls the forms were filled in by the medical supervisor and the mobile intensive care unit physician together. The cause of cardiac arrest was verified from necropsy reports and hospital files by the investigator. The times of the arrival of a first response unit, the arrival of an advanced life support unit, and the arrival of the mobile intensive care unit at the patient's side as well as the time for the return of spontaneous circulation were registered. All data were saved into a special computer file.

Modification—In this study time zero began when the call was first received whereas in the Utstein recommendations time zero begins at the time of collapse. We used this modification because the collapse-to-call interval is difficult to define exactly in minutes by an agitated bystander or when the arrest is not witnessed.

OUTCOME TRACKING

The end points of the study were death or survival to discharge. Data were obtained from hospital records by a coordinating physician. The quality of secondary survival at the time of discharge was measured by a three-tiered classification:

1 Capable of leading independent life at home.

2 Discharge to rehabilitation centres with moderate disability with the ultimate purpose of rehabilitation to be able to live at home independently.

3 Total disability, not capable of selfcare.

Favourable outcome was defined as discharged alive with quality category 1 or 2.

STATISTICAL METHODS

Statistical analysis, which concentrated on finding factors related to survival, was performed by a statistician. An exact chi-squared test (non-parametric data) and Student's t test (parametric data) were used in univariate analysis and a logistic regression model was used for multivariate analysis.

Results

Four hundred and twelve consecutive patients were considered for resuscitation. Four hundred and eighty four additional patients had irreversible signs of death on the arrival of the first response unit, and were not included in the study. They were used in the calculation of the overall out-of-hospital death rate, however. All patients were followed up until death, discharge home or to a rehabilitation centre, or transfer to a chronic care facility. Calculated from the study population, the incidence of sudden out-of-hospital cardiac arrest was 79·8/100 000 inhabitants/year, the

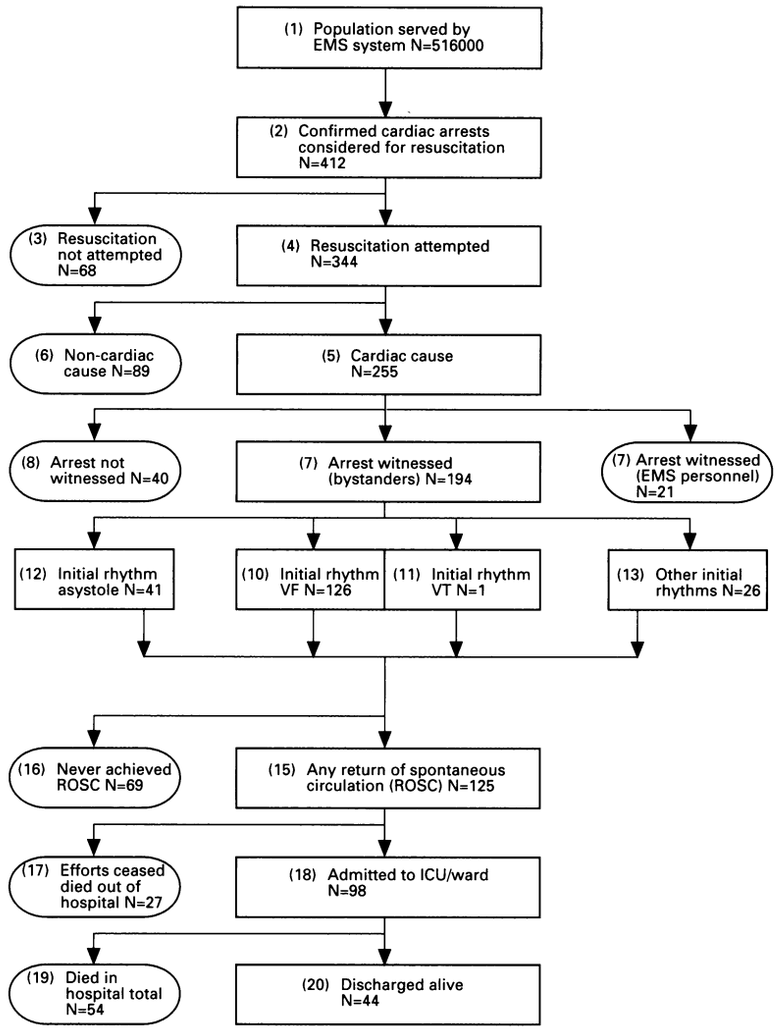

Figure 1 Out-of-hospital cardiac arrests (n = 412) reported on the Utstein template. EMS, emergency medical service; VF, ventricular fibrillation; VT, ventricular tachycardia; ROSC, return of spontaneous circulation; ICU, intensive care unit.

corresponding numbers for sudden non-traumatic cardiac arrest and sudden cardiac arrest of cardiac origin were 73·1 and 53·1/100 000 inhabitants/year, respectively. The total number of deaths from all causes in the community in 1994 was 982 per 100 000 inhabitants, from which out-of-hospital deaths accounted for 147 per 100 000 inhabitants (15·0%). The mean (SD) age of the patients was 62·2 years (18·4), range from three months to 94 years and 279 (67·8%) were male. Eight patients (1·9%) were under the age of 16 years.

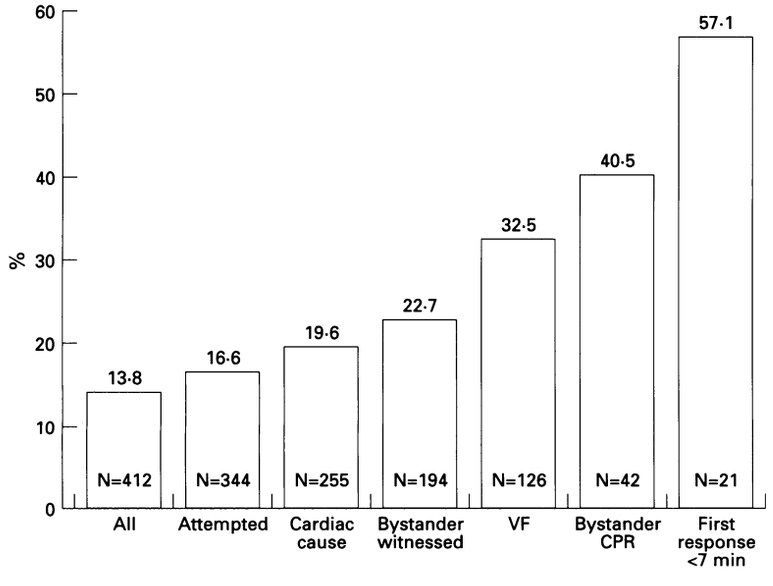

Figure 2 Survival from out-of-hospital cardiac arrest in different subgroups. Each category represents a subset of the preceding category. VF, ventricular fibrillation; CPR, cardiopulmonary resuscitation.

Figure 1 shows the cardiac arrests placed in the Utstein template and figure 2 shows survival in different subgroups. The overall survival rate in attempted resuscitations was 16·6% (57/344). One hundred and twenty six patients had a bystander witnessed cardiac arrest of cardiac origin with an initial rhythm of ventricular fibrillation: in 98 of them (77·8%) spontaneous circulation was restored. Eighty (63·5%) were admitted to an intensive care unit or a hospital ward and 41 (32·5%) were discharged alive. Survival to hospital admission and to discharge according to the initial rhythm is shown in table 1. The total number of survivors from all subgroups was 57 (including those with an unwitnessed arrest or a non-cardiac cause): 46 were discharged home, four were discharged to a rehabilitation centre, and seven were discharged to a chronic care facility with permanent severe disability because they were not capable of selfcare. Two of the patients discharged to a chronic care facility had severe disability before cardiac arrest and there was no change in their status after discharge. Thus a favourable outcome was registered for 50 (87·7%) of the 57 survivors and for 38 of 41 (92·7%) of those in ventricular fibrillation.

The origin of the cardiac arrest was cardiac in 274 (66·5%) cases (all template subgroups included). Ventricular fibrillation was the initial rhythm in 65·0% of bystander witnessed cases of cardiac origin. The collapse was bystander witnessed in 264 (64·1%), unwitnessed in 97 (23·5%), and witnessed by emergency medical service personnel in 51 (12·4%) cases. The dispatching centre recognised 273 (75·6%) of 361 cardiac arrests (those witnessed by emergency medical service personnel were excluded). In the remaining 88 cases the first response unit found a patient in an unexpected cardiac arrest: six had collapsed after the call. Two hundred and twenty eight (55·3%) patients collapsed at home or in other private premises, 9 (2·2%) at work, 158 (38·3%) in public place, 15 (3·6%) in a care facility, and data were not available in two cases. Ninety one (22·1%) patients received bystander initiated cardiopulmonary resuscitation. The proportion of bystander initiated cardiopulmonary resuscitation was highest (33·3%) in the subgroup with bystander witnessed ventricular fibrillation of cardiac origin.

The mean (SD) time intervals from the receipt of the call for the first response unit, advanced life support unit, and mobile intensive care unit to arrive at the patient's side were 7·0 (3·9), 10·3 (6·0), and 12·6 (7·2) min, respectively, and the interval from the receipt of the call to the return of spontaneous circulation was 16·7 (7·8) min. Corresponding mean values for survivors and non-survivors were

Table 1 Survival to hospital admission and discharge according to the initial rhythm in those patients in whom resuscitation was attempted (A) and in those patients in whom resuscitation was attempted after a cardiac arrest of cardiac origin witnessed by a bystander (B)

	Initial rhythm			
	Ventricular fibrillation	*Ventricular tachycardia*	*Asystole*	*Pulseless electrical activity*
A:				
All (n = 344)	155	2	113	74
Admitted to ICU or ward	97 (62·6%)	1 (50%)	34 (30·1%)	19 (27·5%)
Discharged	47 (30·3%)	1 (50%)	7 (6·2%)	2 (2·7%)
B:				
All (n = 194)	126	1	41	26
Admitted to ICU or ward	80 (63·5%)	1 (100%)	10 (24·4%)	7 (26·9%)
Discharged	41 (32·5%)	1 (100%)	1 (2·4%)	1 (3·8%)

ICU, intensive care unit.

6·0/8·0 (P = 0·0001), 9·1/11·4 (P = 0·0014), and 11·5/14·0 min (P = 0·0189), respectively.

In univariate analysis, factors related to survival were bystander witnessed arrest (P = 0·001), ventricular fibrillation as initial rhythm (P < 0·001), bystander initiated cardiopulmonary resuscitation (P = 0·002), and time intervals as shown in the previous paragraph. In multivariate analysis (logistic regression model) age (OR 1·03, 95% CI 1·01 to 1·06), bystander witnessed arrest (OR 8·57, 95% CI 1·84 to 40·07), ventricular fibrillation as initial rhythm (OR 4·43, 95% CI 1·60 to 12·28), and the call-to-arrival interval of the first response unit (OR 1·25, 95% CI 1·06 to 1·46) were independent factors related to survival. Table 2 gives specific data on patients with bystander witnessed arrest of cardiac origin with ventricular fibrillation as the initial rhythm.

The physician on duty decided not to attempt resuscitation in 68 (16·5%) patients. The causes of the do-not-resuscitate decision were injury in 30, long collapse-to-arrival interval for the first reponse unit in 19, incurable illness such as metastatic cancer or severe dementia in 10, living will in two, and a combination of at least two of the above causes in four cases. Data were not available in three cases.

Table 2 Comparison of survival and resuscitation data in 126 cardiac arrest patients in whom resuscitation was attempted: the arrest was bystander witnessed, of cardiac origin, and the first recorded rhythm was ventricular fibrillation

	Survived	*Died*	*P*
Sex:			
Male	34	61	
Female	7	23	0·205
Age (y) (mean (SD))	62·0 (12·6)	68·9 (14·8)	0·012
Bystander cardiopulmonary resuscitation:			
Yes	17	25	
No	24	60	0·179
Scene of collapse:			
Home	11	43	
Work	2	2	
Public place	27	38	
Care facility	1	2	0·086
Recognition of cardiac arrest by the dispatching centre:			
Yes	11	25	
No	30	60	0·764
Time-intervals (min) (mean (SD)):			
To first responding unit	5·7 (2·3)	7·4 (2·6)	0·001
To ALS unit	9·3 (4·5)	10·6 (6·4)	0·187
To MICU	11·7 (6·2)	13·7 (7·8)	0·173
To ROSC	14·7 (6·5)	18·4 (7·8)	0·016
Venous cannulation:			
External jugular	24	48	
Antecubital	17	37	0·723

ALS, advanced life support; MICU, mobile intensive care unit; ROSC, return of spontaneous circulation. Time intervals for units are calculated from the time the call was first received to the arrival at the patient's side.

Discussion

Survival from out-of-hospital cardiac arrest (16·6% in attempted resuscitation and 32·5% in bystander witnessed ventricular fibrillation of cardiac origin) is comparable to reports from the suburban United States (King County) (16 and 34% respectively).[2] However, the response times of the first response units are longer and cardiopulmonary resuscitation performed by citizens is relatively rare in Helsinki compared with King County. Current knowledge indicates that middle-sized urban emergency medical services systems (population approximately 500 000) are optimal for survival from out-of-hospital cardiac arrest. Survival rates have been reported to be lower both in rural and small city emergency medical services systems[7 8] and in large cities.[9 10] Very large emergency medical services systems are more difficult to coordinate and supervise, it may take too long to arrive at the patient's side. Also sociodemographic features typical of large cities (poverty, poor baseline health) may contribute to low survival rates.[10]

Becker *et al* reviewed 20 publications which included information about the incidence of out-of-hospital cardiac arrest.[11] Incidence rates varied markedly, from 35 to 128 per 100 000, with a mean of 62. The knowledge of case definition, the availability of necropsy reports and the comprehensiveness of the emergency medical services are relevant when interpreting incidence rates. Cardiac causes are likely to be overestimated if the cause of cardiac arrest is ascertained purely on the basis of the clinical situation and preexisting history.[5] We expressed our results as three incidence rates (overall 79·8, non-traumatic 73·1, and cardiac 53·1/100 000) to make the comparison more reliable.

Compared with the previous report from Helsinki in 1987[5] the overall incidence of sudden out-of-hospital cardiac arrest had decreased from 112·6 to 79·8/100 000 without a major change in the incidence of ventricular fibrillation. Survival from ventricular fibrillation (defined as witnessed arrest with presumed heart disease including arrests witnessed by emergency medical personnel in 1987[5] and bystander witnessed arrest of cardiac origin in the present study) has increased from 27 to 32·5%. The introduction of automated electrical defibrillators is thought to have had a major impact on the increased survival rate.[12] The results of the previous study[5] and the present one are not altogether comparable because between studies the Utstein style data collection system was introduced in Helsinki. Because of the different calculation principles (the receipt of the call *v* dispatching, and arrival at the patient's side *v* arrival at the scene) time intervals cannot be compared directly, but it seems that the crucial intervals are at least as long as in 1987.[5] The results of the multivariate analysis are comparable with previous studies from different emergency medical services, although the factor of bystander initiated cardiopulmonary resuscitation did not reach the level of statistical significance in this study.[9 13]

The chance of survival is low if the initial rhythm recorded is asystole or pulseless electrical activity. In a series of 1222 patients from Gothenburg treated by the emergency medical services with asystole as the initial rhythm, 7% of the patients were admitted to hospital and 2% were discharged.[14] The corresponding figures were 13% and 2% when electromechanical dissociation was the initial rhythm in 748 cases.[15] In another recent study discharge rates for patients initially found in asystole and electromechanical dissociation were 1·6% and 6·9%, but most cardiac arrests with a non-cardiac cause had been excluded.[16] The 6·2% overall survival rate in cases of asystole in this study is higher than previously reported,[14 16] but the rate is reduced to 2·5% in cases of witnessed arrests of cardiac origin. The difference may be explained by the contribution of cardiac arrests of non-cardiac origin known to be associated with better prognosis (near-drowning[17] or airway obstruction). Although the survival rates remain low in cases of asystole and in cases of pulseless electrical activity, such cases can make up more than one fifth of the total survivorship, which makes resuscitation efforts in such cases worthwhile.[16]

Bystander initiated cardiopulmonary resuscitation improves survival from out-of-hospital cardiac arrest by maintaining minimal vital organ perfusion until spontaneous circulation is restored and perhaps most importantly by maintaining the heart in ventricular fibrillation and making it easier to convert by defibrillator.[13 18] These findings are also supported by this study where the frequency of bystander cardiopulmonary resuscitation was highest in the ventricular fibrillation group, but the relation to survival remained statistically non-significant. However, the overall 22·1% bystander cardiopulmonary resuscitation rate in Helsinki is alarmingly low for a developed emergency medical services system and compared with the situation in—for example, New York.[10] The reason for the low rate may be the lack of adequate education rather than the reluctance of people to initiate cardiopulmonary resuscitation.

In one quarter of cases a cardiac arrest remained unrecognised by the dispatching centre, the corresponding figure in 1987–88 was 47%.[19] A cardiac arrest can be recognised over the telephone if the caller can answer three simple questions: What has happened? Is the patient awake/can she be woken up? Is she breathing normally? In most cases that remained unrecognised the caller did not know what had happened: he had merely been asked to call an ambulance quickly. In the remaining cases the dispatching protocol was not obeyed. Public education on making an emergency call and continuing education and support of the dispatchers are needed to raise the cardiac arrest recognition rate. It is obvious that dispatching should receive more attention in data collection in the future.

Utstein style reporting was found to be suitable for prospective data collection in this emergency medical services system. We chose to record the time when the call was first received as time zero, contrary to the Utstein recommendation. It is possible to record the interval between the call receipt and arrival at the scene or preferably at the patient's side in seconds and that is why it should be separated from the less exact collapse-to-call interval.

The weakest part in the chain of survival in Helsinki emergency medical services system seems to be early access and early bystander cardiopulmonary resuscitation. Collapse-to-call intervals are too long and bystander initiated cardiopulmonary resuscitation uncommon. Educational programmes for citizens should include how to recognise an emergency, how to make a correct emergency call so that the dispatching centre can make a risk evaluation and use scarce resources reasonably, and when and how to start citizen cardiopulmonary resuscitation.

CONCLUSIONS

Since late 1980s after major changes in emergency medical services system were implemented, survival from out-of-hospital cardiac arrest has markedly increased. However, early access, the weakest link in the chain of survival needs major attention and development in the near future. Utstein style reporting with a modified time zero was found to be an appropriate, although laborious, approach to data collection.

We thank Dr Per Rosenberg for valuable comments, Anneli Ojajärvi, for statistical review , Matti Nieminen, ADP designer, for help in developing the computer based data collection system, Leena-Marja Kokko, for assistance in data processing and the Laerdal Foundation for financial support.

1 Cummins RO, Chamberlain DA, Abramson NS, Allen M, Baskett P, Becker L, *et al.* Recommended guidelines for uniform reporting of data from out-of-hospital cardiac arrest: the Utstein style. *Ann Emerg Med* 1991;**20**: 861–74.
2 Eisenberg MS, Cummins RO, Larsen MP. Numerators, denominators, and survival rates: reporting data from out-of-hospital cardiac arrest. *Am J Emerg Med* 1991; **9**:544–6.
3 Valenzuela TD, Spaite DW, Meislin HV, Clark LL, Ewy GA. Case and survival definitions in out-of-hospital cardiac arrest: effect on survival rate calculation. *JAMA* 1992;**267**:272–4.
4 Joslyn SA. Case definition in survival studies of out-of-hospital cardiac arrest. *Am J Emerg Med* 1994;**12**:299–301.
5 Silfvast T. Prehospital resuscitation in Helsinki, Finland. *Am J Emerg Med* 1990;**8**:359–64.
6 American Heart Association. Guidelines for cardiopulmonary resuscitation and emergency cardiac care. Recommendations of the 1992 national conference. *JAMA* 1992;**268**:2251–75.
7 Stults KR, Brown DD, Schug VL, Bean JA. Prehospital defibrillation performed by emergency medical technicians in rural communities. *N Engl J Med* 1984;**310**: 219–23.
8 Bachman JW, McDonald GS, O'Brien PC. A study of out-of-hospital cardiac arrests in Northeastern Minnesota. *JAMA* 1986;**256**:477–83.
9 Becker LB, Ostrander MP, Barrett J, Gondos GT. Outcome of CPR in a large metropolitan area—where are the survivors. *Ann Emerg Med* 1991;**20**:355–61.
10 Lombardi G, Gallagher J, Gennis P. Outcome of out-of-hospital cardiac arrest in New York City. The pre-hospital arrest survival evaluation (PHASE) study. *JAMA* 1994; **271**:678–83.
11 Becker LB, Smith DV, Rhodes KV. Incidence of cardiac arrest: a neglected factor in evaluating survival rates. *Ann Emerg Med* 1993;**22**:86–91.
12 Weaver WD, Hill D, Fahrenbruch CE. Use of the automatic external defibrillator in the management of out-of-hospital cardiac arrest. *N Engl J Med* 1988;**319**:661–6.
13 Herlitz J, Ekström L, Wennerblom B, Axelsson Å, Bång A, Holmberg S. Effect of bystander initiated cardiopulmonary resuscitation on ventricular fibrillation and survival after witnessed cardiac arrest outside hospital. *Br Heart J* 1994;**72**:408–12.
14 Herlitz J, Ekström L, Wennerblom B, Axelsson Å, Bång A, Holmberg S. Predictors of early and late survival after out-of-hospital cardiac arrest in which asystole was the first recorded arrhythmia on scene. *Resuscitation* 1994; **28**:27–36.

15 Herlitz J, Ekström L, Wennerblom B, Axelsson Å, Bång A, Holmberg S. Survival among patients with out-of-hospital cardiac arrest found in electromechanical dissociation. *Resuscitation* 1995;**29**:97–106.
16 Pepe PE, Levine RL, Fromm RE, Curka PA, Clark PS, Zachariah BS. Cardiac arrest presenting with rhythms other than ventricular fibrillation: contribution of resuscitative efforts toward total survivorship. *Crit Care Med* 1993;**21**:1838–43.
17 Kuisma M, Suominen P, Korpela R. Paediatric out-of-hospital cardiac arrests—epidemiology and outcome. *Resuscitation* 1995;**30**:141–50.
18 Swor RA, Jacson RE, Cynar M, Sadler E, Basse E, Boji B, *et al.* Bystander CPR, ventricular fibrillation, and survival in witnessed, unmonitored out-of-hospital cardiac arrest. *Ann Emerg Med* 1995;**25**:780–4.
19 Silfvast T. Prehospital resuscitation in Helsinki. Experience with a physician staffed emergency care unit in 1987–1988. Helsinki: University of Helsinki, 1990: 28pp. Dissertation.

IMAGES IN CARDIOLOGY

Earthquake tachycardia in Belgium

A 52 year old woman complained of recurrent palpitation. Clinical examination, electrocardiogram, echocardiogram, and exercise testing were entirely normal. Holter monitoring showed a normal sinus rhythm (average 69 beats per minute) at night, until on 20 June 1995 she was woken suddenly at 4·05 am by an earthquake (4·4 on the Richter scale). The earthquake was followed by sinus tachycardia (recognised by the patient as her usual arrhythmia) of up to 150 beats per minute.

The figure shows (A) the electrocardiographic tracing and (B) the heart rate trend. The standard deviation of the normal RR intervals measured in the 15 minutes immediately before she was woken was 42 ms. Heart rate (HR) variability was further analysed with power (P) spectral analysis using fast Fourier transformation (FFT). This quantifies the high frequency (HF) and low frequency (LF) components of the total (T) power spectrum. Her sudden awakening probably induced sympathetic activation with disappearance of vagal tone. This is reflected by the change in the LF/HF balance, caused by the loss of the HF component—(C) before waking (D) after waking.

These findings confirm how external factors (and others such as pain and emotion) can induce sudden and strong adrenergic stimulation. In Los Angeles and Kobe earthquakes were associated with an increase in the cardiac event rate.[1]

MICHEL DE PAUW
RENE TAVERNIER
LUC JORDAENS
Department of Cardiovascular Diseases
University Hospital Ghent,
Ghent, Belgium

1 Leor J, Kloner RA. Scared to death? The occurrence of sudden cardiac death during the 1994 Northridge Earthquake (abstract). *Circulation* 1995;**92** suppl:I 96.